

tial to the life of a University. "I appreciate," he says, "at its full value this last advantage, when, looking back, I recall my student days, and the impression made upon us by a man like Johannes Müller, the physiologist. When one finds himself in contact with a man of the first order, the entire scale of one's intellectual conceptions is modified for life; contact with such a man is perhaps the most interesting thing life may have to offer."

Now, the form in which Johannes Müller stated what we may regard as the germ which fertilized the physiology of the senses is this, that the difference in the sensations due to different senses does not depend upon the actions which excite them, but upon the various nervous arrangements which receive them.

To accept this statement out of a book, as a matter of dead faith, may not be difficult to an easy-going student; but when caught like a contagion, as Helmholtz caught it, from the lips of the living teacher, it has become the guiding principle of a life of research.

No man has done more than Helmholtz to open up paths of communication between isolated departments of human knowledge; and one of these, lying in a more attractive region than that of elementary psychology, might be explored under exceptionally favourable conditions, by some of the fresh minds now coming up to Cambridge.

Helmholtz, by a series of daring strides, has effected a passage for himself over that untrodden wild between acoustics and music—that Serbonian bog where whole armies of scientific musicians and musical men of science have sunk without filling it up.

We may not be able even yet to plant our feet in his tracks and follow him right across. That would require the seven league boots of the German colossus; but to help us in Cambridge we have the Board of Musical Studies, vindicating for music its ancient place in a liberal education. On the physical side we have Lord Rayleigh laying the foundation deep and strong in his "Theory of Sound." On the æsthetic side we have the University Musical Society doing the practical work, and in the space between, those conferences of Mr. Sedley Taylor, where the wail of the siren draws musician and mathematician together down into the depths of their sensational being, and where the gorgeous hues of the phoneidoscope are seen to seethe and twine and coil like the

"Dragon boughs and elvish embleings"

on the gates of that city where

"an ye heard a music, like enow
They are building still, seeing the city is built
To music, therefore never built at all,
And therefore built for ever."

The special educational value of this combined study of music and acoustics is that more than almost any other study it involves a continual appeal to what we must observe for ourselves.

The facts are things which must be felt; they cannot be learned from any description of them.

All this has been said more than two hundred years ago by one of our own prophets—William Harvey, of Gonville and Caius College. "For whosoever they be that read authors, and do not by the aid of their own senses, abstract true representations of the things themselves (comprehended in the author's expressions) they do not resent true ideas, but deceitful idols and phantasms, by which they frame to themselves certain shadows and chimæras, and all their theory and contemplation (which they call science) represents nothing but waking men's dreams and sick men's phrensies."

Prof. Maxwell was assisted in his practical demonstrations by Mr. Garnett, of St. John's College.

SOCIETIES AND ACADEMIES LONDON

Physical Society, April 13.—Prof. R. B. Clifton, vice-president, in the chair.—The following candidates were elected Members of the Society:—W. Campbell, R. W. F. Harrison, Rev. T. N. Hutchinson, M.A., B. W. Richardson, M.B., F.R.S.—The Secretary read a paper by Messrs. J. Nixon and A. W. Heaviside, describing their experiments on the mechanical transmission of speech through wires or other substances, to which Mr. Preece had referred at a previous meeting of the Society. After describing a number of experiments in which metallic discs soldered on to the ends of the conducting wires

were employed, they went on to enumerate the more successful experiments in which wooden discs were mainly employed. The first actual transmission of speech was effected by placing the belly of a violin against the receiving end of the wire, when every syllable spoken was distinctly audible. Very good results were obtained by employing mouth-and-ear pieces, formed as in a telephone, the disc being replaced by thin wooden discs, six inches in diameter, and a No. 4 wire was found to be most satisfactory. On suspending a length of this wire in such a manner that it had no rigid attachments, it was ascertained that 120 yards is the limit through which a conversation can be carried on.—Capt. Abney, F.R.S., described the method he adopted for photographing the least refrangible end of the spectrum. He pointed out that it is impossible, with the ordinary sensitive salts employed in the usual way, to photograph further than the Fraunhofer line E, though by a preliminary exposure to light of a Daguerrotype plate, Draper was able to photograph beyond the extreme limit of visibility in the red end of the spectrum. This method, however gave what is known as a reversed picture, the lights and shades being transposed, besides requiring a lengthened exposure. It enabled Becquerel to photograph the spectrum in its natural colours, and later St. Victor obtained coloured images of coloured cloths. The object of Capt. Abney had been to obtain unreversed pictures of this portion of the spectrum; in other words, to obtain a compound that would be similarly sensitive to the red and the blue components of white light. Such a compound he had at last obtained by what he termed *weighting* silver bromide with resin, and now he obtains it by causing the molecules of silver bromide to weight themselves. He showed an ordinary bromide of silver plate, and the colour of the transmitted light was of a ruddy tint, showing absorption of the blue rays; another film was shown containing weighted bromide of silver, which transmitted blue light and absorbed the red. Photographic plates prepared with the latter compound he showed were sensitive to the red and ultra-red waves of light, and he threw on the screen photographs of the spectrum from the line C to a wave-length of 10,000, the ultra-red showing remarkable groupings of lines. He further showed that by friction the blue film was changed to the red, and in that state was not sensitive to the lower part of the spectrum. These photographs were taken by means of a diffraction grating, and Capt. Abney demonstrated Fraunhofer's method of separating the various orders of spectra produced by it. He then explained that recently he had elucidated the reason of the reversal of Draper's pictures by the least refrangible end of the spectrum. He finds that it is accelerated by exposing the plates in weak oxidising solutions, such as those of hydroxyl, bichromate of potash, permanganate of potash, and nitric acid, or exposure to ozone. The red rays, in other words, seemed to oxidise the photographic image, and to render it incapable of development.—Mr. H. Bauermathen exhibited some paper models illustrative of the disposition of the planes of symmetry in crystals. These included octants of the sphere with inclosed cube and octahedron faces pointed into their corresponding hexakis-octohedral faces, a cubic skeleton built up from nine planes of symmetry with a removable outer shell, and a system of axial planes of an unsymmetrical mineral inclosing a solid nucleus contained between three parallel pairs of planes. They were constructed for the purpose of showing popularly the difference between planes of symmetry and other diametral planes by laying upon them a small mirror or plate of mica, when in the first case the inclosed nucleus gave a symmetrical image corresponding in position to the plane immediately behind the mirror, but in the second a broken image is produced.—Dr. Guthrie exhibited the arrangement of apparatus he had employed, in conjunction with his brother, to ascertain the effect of heat on the transpiration of gases. The main difficulty connected with the research was the securing of an absolutely constant pressure on the air operated upon. This was secured by inserting into the neck of the vessel which served as an air-chamber a tube turned up at its inner end and terminating externally by a small funnel; as the tube was kept constantly full of water, the funnel overflowing, a pressure represented by the difference between the heights of these levels was maintained. After passing through a series of drying tubes the air traversed the (U-shaped) capillary tube in a beaker containing water of known temperature, and was finally received in an inverted tube contained in an overflowing dish of water. Among other results it was found that the resistance of a tube is the same as that of its several portions,

and if t be the time occupied, T the absolute temperature, p_1, p_2 the pressures, and α and β constants, they find that—

$$t = \alpha T \left(T + \frac{\beta}{p_1 - p_2} \right).$$

Chemical Society, May 16.—Dr. Gladstone, president, in the chair.—The following papers were read:—On the detection and estimation of free mineral acids in various commercial products, by Peter Spence and A. Esilmann. The method is based on the fact that peracetate of iron even in dilute solutions has a distinct yellow colour, not perceptibly altered by acetic acid or solutions of persulphates, but instantly bleached by free sulphuric, hydrochloric, and nitric acids. The solution is made by dissolving ten parts of iron alum and eight parts of crystallised acetate of soda in 1,000 parts of 8 per cent. solution of acetic acid (25 per cent.).—The action of hypochlorites on urea, by H. G. H. Fenton. The author has found that when urea is acted on by a hypochlorite in the cold, in the presence of a caustic alkali, only half the nitrogen is evolved. From various experiments it was proved that the nitrogen remains behind as a cyanate.—On the behaviour of metallic solutions with filter paper and on the detection of cadmium, by T. Bayley. The author has investigated the action which takes place when drops of metallic solutions are placed on filter paper, the extent to which the solutions spread being tested by sulphuretted hydrogen. In some cases the solution seemed to concentrate itself in the middle, in others round the edge of the spot. Dilution, temperature, and the kind of filter paper used, have an important influence on this phenomenon. The salts of silver, lead, &c., when moderately concentrated, give a wide water ring containing no metal, while the salts of copper, nickel, cobalt, and especially cadmium, must be much more dilute to present the same appearance. This property of cadmium to spread itself over the whole drop is so marked that it affords an elegant means of detecting it in the presence of metals whose sulphides are black.—On essential oil of sage, by S. Siguira and M. M. P. Muir. The oil consists mainly of two terpenes, one boiling at 152–156° the other 162–167°, an oxidised liquid and a camphor.—A small quantity of absolutely pure sage oil has been examined, and consists mainly of a terpene boiling at 264–270°, of a dark emerald green colour.—On the action of bromine upon sulphur, by J. B. Hannay. The author has investigated the evidence as to the existence of any compounds of these two elements by boiling points, the spectrum of the vapour, specific gravity, and vapour tension. He concludes that the action of any quantity of bromine or any quantity of sulphur is an action on the whole mass and not in multiple proportion, but that if at low temperatures the compound containing one atom of sulphur to two of bromine meets a body with which it can form a molecular combination, e.g., arsenic, it assumes the crystalline form in conjunction with such a body.—On the determination of high boiling-points, by T. Carnelly and W. C. Williams. The authors have determined the boiling-points of various substances by observing whether or not certain salts fuse when exposed to the vapour of the boiling substance. The melting-points of the salts have been determined by Carnelly. The salts are contained in capillary tubes.—On high melting-points, Part IV., by T. Carnelly, D.Sc. The author has perfected his (specific heat) method of determining melting-points, and eliminated two sources of error. In the present paper he gives the melting-points of over one hundred substances. He promises a paper embodying theoretical results deduced from the above observations.

PARIS

Academy of Sciences, May 27.—M. Fizeau in the chair.—The following among other papers were read:—On the production and constitution of chromised steels, by M. Boussingault. This memoir gives experiments proving that chromium, without the presence of iron, does not communicate to pure iron the properties of steel; analyses of cast chromium steel; experiments on the temper, and resistance to shock and traction, of chromised steel; mode of preparation of it and ferrochrome, &c.—On the action of anesthetics on the respiratory centre and cardiac ganglions, by M. Vulpian. In chloralised dogs faradisation of the upper cephalic segments of the cut vagi stops the respiratory movements just as in dogs not anaesthetised; but whereas, in the latter, the respiration in general easily and spontaneously commences again, spite of the electrification being continued, it is not so with the former, and the animals die unless electrification be stopped and artificial respiration be produced, aided, it may be, by energetic faradisation of the trunk. The heart, too, may finally stop in such a case. M. Vulpian thinks this explains certain accidents in clinic anaesthesia.—On the origin

of the excito-sudoral nerve-fibres in the sciatic nerve of the cat by M. Vulpian. Those in the abdominal cord of the great sympathetic come from the spinal cord, chiefly by the first and second lumbar nerves; but there are others, and more, which come directly from the spinal cord by the roots of the sciatic nerve. An analogy with the nerves of the salivary glands is indicated.—M. de Lesseps gave details of the pacific conquests, made in the name of the Khedive of Egypt, by Gen. Gordon, and quoted from an official Egyptian report on Capt. Burton's recent important discoveries in Arabia.—Transparent hydrated silica and hydrophane opal, obtained by action of oxalic acid on alkaline silicates, by M. Monier. The experiment should be made with 500 to 600 grammes of silicate of 35° or 40° B; the oxalic acid is diluted to only four degrees. Letting the acid act six months at ordinary temperature, a transparent silicious layer was obtained, which, after heating to expel hygrometric water, took the milky colour and the hardness of opal. It becomes translucent again in water.—On the cost of establishment of lightning-conductors, by M. Melsens. He proves that his system of numerous free conductors and multiple earth-connections is generally less expensive than the construction of the ordinary lightning-conductors.—On a disorder, not hitherto described, of wines of the south of France called *vins tournés*, by M. Gautier. This appears after warm and rainy autumns. The wine becomes troubled, its surface irised; the colouring matter passes from red to violet-blue, and is precipitated, the supernatant liquor being yellowish-brown, and having a baked odour and an acidulated and slightly bitter taste. These changes are worked by a parasite which appears in filamentous form in the deposit.—On the production of the luminous sensation, by M. Charpentier. Where we find less red substance in the retina, we observe a less luminous sensibility, and wherever the red appears in excess this sensibility is exaggerated. It is concluded that the luminous sensibility, defined as the simple and original reaction of the visual apparatus to all luminous excitations of whatever nature, is in relation to the degree of photo-chemical action exercised on the red of the retina by all the luminous rays.—On the physiological properties of conine, by MM. Bochefontaine and Tirakian. Conine pure, or bromhydrate of conine, is not a very formidable poison, and not to be compared with hydrocyanic acid (as has been supposed). 65 centigr. of pure conine introduced under the skin of a dog weighing 7 kil. odd killed it in a little over twelve hours; 50 centigr. sufficed for a similar dog when introduced into the stomach. The chlorhydrate and bromhydrate are always more active than the pure conine. M. Mourut has separated from the conine furnished as pure in shops a resinoid matter, which, like curare, paralyses the motor nerves.—*Rôle* of auxiliary acids in etherification; thermal experiments, by M. Berthelot.—On some peculiarities presented in the arrangement of fire-damp in pits and old works, by M. Coquillion.

CONTENTS

PAGE

MODERN NAVAL ARCHITECTURE. By E. J. REED, C.B., M.P., F.R.S.	137
TROPICAL NATURE. By Prof. E. PERCEVAL WRIGHT	140
LETTERS TO THE EDITOR:—	
Extinct and Recent Irish Mammals.—Prof. A. LEITH ADAMS.	141
Hints to Workers with the Microscope.—F. A. BEDWELL.	141
The Virial in Thermodynamics.—Prof. A. S. HERSCHTEL.	142
The Meteor of May 12.—J. EDMUND CLARK.	142
"Divide et Impera."—E. W. WHITE, F.Z.S., S.S.Z.A.	142
A Quadruple Rainbow.—HENRY P. DOWLING	142
Classes for Women at University College.—TALFOURD ELY.	143
PROF. JOSEPH HENRY, LL.D.	143
MAJOR-GENERAL SIR ANDREW SCOTT WAUGH.	145
THE HARVEY TRICENTENARY	145
OUR ASTRONOMICAL COLUMN:—	
The Transit of Mercury	147
The Zodiacal Light and Sun-spot Frequency	148
THE INTERNATIONAL GEOLOGICAL CONGRESS. By Prof. T. STERRY	
HUNT, Secretary of the International Committee	148
A KINEMATICAL THEOREM. By A. B. KEMPE	148
OLD MAPS OF AFRICA (<i>With Maps</i>)	149
COSMIC METEOROLOGY, II. By JOHN ALLAN BROWN, F.R.S.	151
THE NUTRITION OF <i>DROSERA ROTUNDIFOLIA</i> . By FRANCIS DARWIN	153
PHYSICAL SCIENCE FOR ARTISTS, V. By J. NORMAN LOCKYER, F.R.S. (<i>With Illustrations</i>)	154
THE MICROPHONE IN SURGERY	157
NOTES	157
THE REDE LECTURE. By Prof. CLERK-MAXWELL, F.R.S.	159
SOCIETIES AND ACADEMIES	163

ERRATA.—In Prof. Lankester's review of Balfour's "Elasmobranch Fishes," vol. xviii. p. 114, 2nd column, line 22 from top, for *homogeneous* read *homogenetic*. In Dr. Siemens' letter on the microphone, p. 129 1st column, lines 25 and 28 from top, for *corpuscular bodies* read *corpuscular matter*.